WE CLAIM:

1. A micro-electro-mechanical-system (MEMS) mirror device, comprising:

a mirror having a 2-dimensional rotational articulated hinge at a first end, and having a 1-dimensional rotational articulated hinge at a second end opposite the first end;

a movable cantilever connected to the mirror through the 1-dimensional rotational articulated hinge;

a support structure connected to the mirror through the 2-dimensional rotational articulated hinge and connected to the movable cantilever;

whereby movement of said movable cantilever causes rotation of the mirror in a first axis of rotation, and the mirror is also rotatable about a second torsional axis of rotation perpendicular to said first axis of rotation.

2. A device according to claim 1 wherein the 2-dimensional rotational articulated hinge comprises:

a first 1-dimensional rotational articulated hinge having a first mounting point at a first end and having a second end;

a second 1-dimensional rotational articulated hinge having a second mounting point at a first end and having a second end, the second end of the first 1-dimensional rotational articulated hinge being connected to the second end of the second 1-dimensional rotational articulated hinge;

a third 1-dimensional rotational articulated hinge connected to the second ends of the first and second articulated 1-dimensional rotational hinges;

whereby the first 1-dimensional rotational articulated hinge and the second 1-dimensional rotational articulated hinge define the first axis of rotation between the first and second mounting points, and the third 1-dimensional rotational articulated hinge and the 1-dimensional rotational articulated hinge at the second end of the mirror define the second torsional axis of rotation perpendicular to the first axis of rotation.

3. A device according to claim 2 wherein each 1-dimensional rotational articulated hinge comprises a respective articulated beam having a large thickness to width aspect ratio.

4. A device according to claim 2 wherein each 1-dimensional rotational articulated hinge comprises a respective articulated beam having a large thickness to width aspect ratio, the beam being formed of a material or materials selected from a group consisting of silicon, polysilicon, Silicon Nitride, Silicon dioxide, and metallic depositable materials.

5. A device according to claim 3 wherein the beams are formed of a unitary construction.

6. A device according to claim 3 wherein the beams the mirror, and the movable cantilever are formed of a unitary construction.

7. A device according to claim 1 in which the mirror has an angular range of motion at least 0.3 degrees in each axes.

8. A device according to claim 1 further comprising electrodes for applying electrostatic force to the mirror so as to move the mirror in the first and second axes of rotation.

9. A device according to claim 8 wherein the electrodes comprise two electrodes each for applying a respective electrostatic force to the mirror so as to move the mirror in a respective direction in the second axis of rotation, and at least one electrode for applying electrostatic force to the movable cantilever so as to move the mirror in the first rotational axis.

10. A device according to claim 9 wherein said at least one electrode comprises two electrodes mounted on the support structure each for applying a respective electrostatic force to the moving cantilever so as to move the mirror in a respective direction in the first rotational axis.

11. A device according to claim 10 wherein said support structure comprises a first region on a first side of the movable cantilever to which is mounted a first of said two electrodes for applying electrostatic force to the movable cantilever, and a second region opposite the moving cantilever to the first region to which is mounted a second of said two electrodes for applying electrostatic force to the movable cantilever.

12. A device according to claim 1 further comprising:

a rigid extension of the movable cantilever extending beyond where the support structure is connected to the movable cantilever in a direction opposite to the mirror;

whereby movement of the extension of the movable cantilever causes a corresponding opposite movement of the movable cantilever.

13. A device according to claim 12 comprising a first electrode for applying electrostatic force to the mirror so as to move the mirror in a first direction in the first axis of

rotation, and a second electrode for applying electrostatic force to the mirror so as to move the mirror in a second direction in the first axis of rotation.

14. A device according to claim 13 wherein the first electrode for applying electrostatic force to the mirror so as to move the mirror in a first direction in the first axis of rotation is on the support structure proximal the moving cantilever, and the second electrode for applying electrostatic force to the mirror so as to move the mirror in a second direction in the first axis of rotation is on the support structure proximal the extension of the moving cantilever.

15. A device according to claim 12 wherein the moving cantilever and the rigid extension of the moving cantilever are together pivotably mounted to the support structure.

16. A device according to claim 12 wherein the moving cantilever and the rigid extension of the moving cantilever are together rigidly mounted to a portion of the support structure which is sufficiently flexible to allow the moving cantilever and the rigid extension of the moving cantilever to rotate in the first axis of rotation.

17. A device according to claim 12 wherein moments of inertia of the rigid extension of the moving cantilever substantially balance moments of inertia of the moving cantilever and mirror.

18. A device according to claim 1 in which the mirror is made of silicon plated with a metal.

19. A device according to claim 18 wherein the metal comprises Au, Al or Cu layers.

20. A plurality N of devices according to claim 1 arranged side by side to form a 1xN MEMs array, where $N \geq 2$.

21. A plurality NxM of devices according to claim 1 arranged in N rows of M devices thereby forming an NxM MEMs array, where N≥2 and M≥2.

22. A device according to claim 1 wherein the mirror is used for optical switching.

23. A device according to claim 1 wherein the movable cantilever is used for capacitive, magnetic or optical sensing of mirror position.

24. An optical switch comprising:

a plurality of optical ports;

a plurality of devices according to claim 1 each adapted to switch light between a respective pair of said optical ports.

25. A 2-dimensional rotational articulated hinge for connection to a support structure and a device to be rotated, the hinge comprising:

a first 1-dimensional rotational articulated hinge having a first mounting point at a first end and having a second end;

a second 1-dimensional rotational articulated hinge having a second mounting point at a first end and having a second end, the second end of the first 1-dimensional rotational articulated hinge being connected to the second end of the second 1-dimensional rotational articulated hinge;

a third 1-dimensional rotational articulated hinge having a first end connected to the second ends of the first and second articulated 1-dimensional rotational hinges and having a second end;

whereby the first 1-dimensional rotational articulated hinge and the second 1-dimensional rotational articulated hinge define a first axis of rotation between the first and second mounting points, and the third 1-dimensional rotational articulated hinge defines a second torsional axis of rotation perpendicular to the first axis of rotation between the first end and second end of the third 1-dimensional rotational articulated hinge.

26. A 2-dimensional articulated hinge according to claim 25 wherein each 1-dimensional rotational articulated hinge comprises a respective articulated beam having a high thickness to width aspect ratio.

27. A 2-dimensional articulated hinge according to claim 25 wherein the beams are formed of a unitary construction.

28. A 2-dimensional articulated hinge according to claim 25 wherein the beams are formed of a material or materials selected from a group consisting of silicon, polysilicon, Silicon Nitride, Silicon dioxide, and Metallic depositable materials.